TABLE 1. Growing Degree Days Accumulated During 1982 Through 1985 for Dates of MH Application Which Resulted in at Least 90% Tall Fescue Seedhead Suppression.

Year	Minimum	Maximum
	------------GDD------------	
1982	48	480
1983	338	677
1984	163	461
1985	294	721
Mean	211	585

GDD = Growing degree days accumulated beginning March 1 of each year using a base temperature of 40 degree fahrenheit

examples that the calendar date is an inaccurate reflection of the developmental stage of the grass seedhead. In spring of 1982, studies at NCSU were initiated to monitor the development of tall fescue seedheads and determine how seedhead suppression was affected by the inflorescence developmental stage.

Applications of plant growth regulators (e.g., Maleic hydrazide, Limit@, Embark@) were made between March and May during the springs of 1982-1985. Tall fescue plants were sampled weekly to measure inflorescence length and other morphological characteristics. Plots were also evaluated for turf quality and stand density changes following various dates of application.

Correlations between seedhead length and growth regulator seedhead suppression activity were highly significant. Inflorescence length was found to be inversely related to the seedhead suppression activity of maleic hydrazide, amdiochlor, and mefluidide. Increased seedhead size at the time of application is accompanied by reduced likelihood that growth regulator treatment will suppress inflorescence development. Increases in the length of tall fescue seedheads during the early spring are small. The development of the seedhead during this period is largely that of cell division rather than elongation.

Excellent suppression of tall fescue seedheads was obtained using maleic hydrazide at 4-lb ai/acre applied between the initiation of inflorescence development and the point of rapid elongation of seedhead in late April and early May. Evaluations from 1982 through 1985 have shown that the rapid elongation phase of tall fescue seedhead development begins about 2 weeks before the emergence of the seedhead. Thus, the use of seedhead length as an indicator of potential growth regulator suppression activity would require dissection of the plant. Such monitoring of seedhead length would be (a) difficult to implement in the field, (b) time consuming, and (c) impractical for large areas.

More recently, the relationship between seedhead length, seedhead suppression and growing degree-days (GDD) is being examined as a possible practical approach to defining the activity periods of plant growth regulators. Thus far, a GDD, defined as the degree days accumulated beginning March 1 using a base temperature of 40 degree fahrenheit, has been significantly correlated with the suppression activity of maleic hydrazide, amdochlor, and mefluidide. Tall fescue seedhead suppressison during 1982 through 1985 exceeded 90 percent when maleic hydrazide application was made after a mean GDD accumulation of 211, but before a mean GDD of 585 (Table 1).

At present GDD analysis appears to be a practical approach to identifying growth regulator application windows for acceptable seedhead suppression of tall fescue. Advisories of GDD status would be possible for many locations from local meteorological data.

The Toxicology of Herbicides

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The Roadside industry operates in a "glass bowl" in that a right-of-way is bordered by thousands of people. All road maintenance activities including herbicide applications are witnessed by passersby as well as residents. Most manufacturers of herbicides as well as users have a poor image in this country because they have been the object of considerable publicity, most of it bad. The public, as well as the press, perceives many herbicides as poisons because they associate herbicides with dioxin, arsenic, paraquat, and so forth. This negative public attitude is naturally carried over to the users and manufacturers of these herbicides.

There is positive documentation that the use of herbicides presents the least risk of any other method of vegetation management. Consider the risks associated with riding mowing machines on roadsides with heavy vehicles traveling at high speeds a few feet away; people falling off rotary machines on steep slopes; mower blades striking glass bottles, rocks, and so forth and the hazard to crews using chain saws to remove brush or swing blades to cut herbaceous weeds. Then, there is the problem with resprouting and the whole process of cutting being required several times during a growing season. Herbicides, on the other hand, destroy roots as well as leaves and stems and most have a residual period, which reduces the need for retreatment.

The users of herbicides need to acquaint themselves with their toxicology. Terminology such as LD - lethal dose; LD_{50} - lethal dose 50 percent of the population of test animals; LC - lethal concentration; LC_{50} - lethal concentration to 50 percent of test animals; acute oral - a single dose ingested by mouth; acute dermal - a single dose applied to the skin; and so forth, should be understood and interpreted. A herbicide with an LD_{50} of 10 is very toxic (arsenic trioxide) and has a toxicity rating of 1, whereas a herbicide with an LD_{50} of 5200 (bromacil) is almost non toxic and has a toxicity rating of 5. The higher the LD_{50}, the safer the compound.

Aspirin has an LD_{50} of 2140 (Class 4) and table salt 3320 (Class 4 also). Many herbicides used such as Velpar®, DSMA® (disodium acid methane arsenate), Banvel®, Pramitol®, and atrazine, are below aspirin (in other words they are safer) on the toxicology chart - whereas Karmex®, Roundup®, Oust®, Princep®, Hyvar®, Krovar®, Tordon®, and Krenite®, are below table salt on toxicity charts. This means that in their pure form (active or formulated) most herbicides have a higher LD_{50} and require less to be lethal to people than aspirin or table salt. Yet, these products all are diluted in water before they are applied. In fact, an average dilution is 2 lb to 50 gal (400 lbs) of water, a dilution factor of 200 times. This means that when one is applying 1 lb of Banvel in 25 gals of water, the LD_{50} is being diluted from 2,900 to 290,000. So, in reality, the public is exposed to dilutions that are considered very safe. The story on wildlife and fish is similar. Another important consideration is that most herbicides are not readily absorbed by the skin and when ingested accidentally are readily broken down by the body and dumped as waste.

It is strongly suggested that crews who handle the formulated product follow precisely the instructions on the label relative to protecting eyes, and skin, inhaling the product, sanitary practices and so forth, when applying herbicides. All precautions should be observed.

In general, herbicides do not build up in the soil because some are broken down via microbial degradation and others hydrolyze chemically. Other factors accounting for degradation are absorption to organic matter and clay colloids, leaching by water from the soil, volatility, and/or photodegradation. By and large, microbial degradation is the most important reason for herbicide disappearance. Organisms such as sarcina, bacillus, pseudomonas, xanthomonas, penicillin, and aspergillis are present in most topsoils and they feed on herbicides using them as a source of energy. In time, most of the herbicide is gone and weeds begin to grow, necessitating retreatment. The residual is referred to as "half-life", which varies considerably by product. For instance, it is 4-5 days for 2, 4-D and 1-6 months for Velpar®.

Roadside decisionmakers are urged to properly train spray crews to assure safe and accurate applications. The herbicide should be kept on target and records should be maintained. When mishaps occur or complaints arise, prompt investigations should be initiated to determine what went wrong and every effort should be made to repair the damage, if any.

There are some individuals in our society who object to the use of herbicides. They should be confronted with the facts. Usually, when they have heard the full story, they agree that herbicides are safer, cheaper, more aesthetic, and leave a more functional right of way than the alternative methods of vegetation management. By using only safe herbicides and making proper and safe applications, public safety can be assured and the mission can still be accomplished.